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ABSTRACT

Because state mandated testing has become so important in indicating student achievement in mathematics, measurement has become equally important in indicating student achievement. At the other end of the continuum of assessment, constructivists advocate assessing student achievement within an ongoing lesson or unit of study. The everyday experiences of the student give the mathematics teacher data about how well the learner is achieving. A constructivist approach stresses that the student should improve over his or her past performance. The high standards movement as it relies on standardized testing stresses the importance of outputs, rather than inputs, but constructivism stresses the importance of assisting each student to achieve as optimally as possible. The constructivist approach frowns on the comparison of students and school systems with others, and stresses that a single measurement is not enough to determine student achievement. The use of portfolios, which is in line with constructivist expectations, is difficult because it is harder to document student achievement. Portfolio assessment results may vary with the perspectives of individual raters, but the philosophy behind portfolio development is sound in that the teacher, student, administrator, and parent may actually notice sequential achievement or the lack thereof. (Contains 12 references.) (SLD)

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Mathematics: Measurement Theory Versus Constructivism

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MATHEMATICS: MEASUREMENT THEORY VERSUS CONSTRUCTIVISM

Mathematics instruction needs to follow tenets of educational psychology which assists students to achieve as optimally as possible. State mandated testing has truly taken over as a major means of indicating student achievement in mathematics, as well as in other curriculum areas. Here, measurement becomes an important concept in indicating how well a student is achieving in mathematics. Standardized tests and state developed tests then have become important indicators of learner achievement.

Toward the other end of the continuum, constructivism has numerous advantages over the measurement movement to show student achievement in mathematics. Constructivists advocate assessing student achievement within an ongoing lesson or unit of study.

How does measuring and testing of student achievement compare with constructivism in the mathematics curriculum when analyzing specific areas of the curriculum?

Making Comparisons

A plethora of comparisons may be made between measurement philosophy as compared to constructivism in ascertaining student achievement in mathematics.

All states but one (Iowa) emphasize state mandated standards which each student needs to achieve within their borders. High standards, as a concept, are being emphasized so that students achieve in a competitive manner. How high should the bar then be set? For example, the state of Virginia had a 98 % failing rate of their students on the first Virginia Standards of Learning Test in 1998 (Education Week, January 11, 2001). Are there additional ways of revealing student achievement than through testing and measurement?

In contrast, constructivism emphasizes that students be assessed in mathematics in a contextual situation. The every day experiences of students then provide data to the mathematics teacher as to how well the learner is achieving. The teacher may notice how well the student is doing in developing vital concepts, skills, and attitudes in ongoing lessons and units of study. Assistance may be given to specific contextual difficulties faced by learners on an individual basis. How high to set the standards for students depends upon their individual needs, interests, and abilities (Ediger, 2000, 14-20).

The high standards movement also stresses high expectations to be held by the teacher for each learner's mathematics achievement. The high expectations are to emphasize students meeting the state standards in mathematics. Students then are to measure up to what the state

deems are good standards. These need to be achieved so that students may keep the nation number one in World Class Standards. The national governor's conference in 1989 stated that the United States should be number one in mathematics and science in the world! Test results are to show this number one status when testing students from among the different nations (Ediger, 2000, 181-182).

In comparison, Constructivists believe that students need to be motivated, encouraged and have a developmentally appropriate mathematics curriculum. Each student then is to be motivated/encouraged with a mathematics curriculum appropriate for his/her present achievement level. Continual progress for each student then is a must. Students differ from each other in many ways including abilities, talents, and background information possessed. One size does not fit all when states emphasize that all students need to achieve the same standards or objectives. This is not possible when students possess different intelligences (See Gardner, 1993).

Student achievement may be shown in mathematics from state mandated tests with a numerical result. Generally, the numeral will be a percentile. However grade equivalents, standard deviations, and stanines may also show a student's test results as compared to others in the classroom.Competition is stressed when making these contrasts. Students compete to do and be their best.

Constructivism, on the other hand, stresses that each student improve in achievement over his/her past performance in every day experiences in the classroom. In mathematics, the individual student then is guided to achieve more optimally as compared to previous attempts. Making comparisons with other students is unfair since each learner is a unique person with intrinsic worth (See Ediger, 2000-2001, 18-20).

The high standards movement stresses the importance of outputs, rather than inputs. These outputs may then be shown on report cards when comparisons are made among schools and districts, within a state, in mathematics achievement. The lay public may then view these comparisons in the news media.

In comparison, constructivism emphasizes the importance of assisting each student in the classroom to achieve as optimally as possible. The mathematics teacher is a caring, concerned person who guides each student to do the best possible. Arbitrary standards and expectations for learner achievement are not in evidence. By viewing what a student has achieved previously in mathematics, the teacher is able to determine realistic goals for mathematics achievement.

High standards and expectations philosophy of instruction stresses competition among students being vital to promote the best within each student in mathematics. If the United States is to keep up with other nations on the planet earth, then their student achievement needs to go

up. World class standards need to be achieved. The third International Science and Mathematics Study (TIMSS) whereby students from the different nations of the world were tested did not provide a good picture of this nation's students. Competition is lacking here in that United States students should be first in the world, especially in mathematics and science if international competition in goods and services produced and sold is to be maintained (See Ediger, Chapter Twelve).

Constructivism frowns upon students and school systems comparing themselves with others. Each student and school system is unique. This nation's mathematics curriculum may not be aligned as well with TIMSS' norms as compared to other nations on the planet earth. There are a plethora of reasons inherent on why one nation may not do as well as the others, including student selectivity or who is chosen to be in the study, such as elimination of mentally retarded students from testing situations. Rather, constructivism states that students should not be compared with others due to unique individual differences. The mathematics curriculum should provide for each student so that success and optimal achievement is possible.

Tests are the only way to ascertain student achievement. These may be either standardized or criterion referenced (CRTs). Numerical results from each student are easy to interpret, such as percentiles, when making comparisons among learners. Parents and the lay public can understand the single numeral of percentiles when viewing student achievement. Standardized test results spread students out from high to low, such as the 99th to the first percentile. Criterion referenced tests do not provide this spread since teachers have the accompanying state mandated objectives which provide guidance for teachers to use in teaching. Mathematics teachers may then choose learning opportunities to align with these state mandated objectives. Testing with the use of CRTs aligns the test questions with the stated objectives. The best test results from students accrue with the alignment. Thus, what is tested upon, students have had opportunities to learn (See Ediger, 2000, 244-249).

Constructivists reply with a single measurement is not adequate to ascertain student achievement. They stress using multiple means of assessment. Thus, teacher observation, discussions, purposeful writing and speaking activities, portfolio contents, as well as a variety of products/processes from learners provide a much better basis for decision making on student achievement as compared to a single test score. Then too, assessment is ongoing and continuous in constructivism philosophy of instruction.

Test data provide an excellent basis for decision making by school personnel. From test results, machine scored, teachers and principals receive information necessary for solid decision making. The precise information provided make for data driven decision making to improve

the mathematics curriculum. Test results are objective with percentiles, standard deviations, grade equivalents, and/or stanines. Print outs from test results provide information on the spread of student scores as well as an item analysis which may be used to to analyze what can be done to improve learner performance, among other information.There is then a plethora of information available to make decisions from objective information (See Popham 1999, 8-15).

In contrast, constructivism is not that certain about the objectivity of information from test results. After all, human beings write the tests. They are removed in time and place from the local classroom where the tests are administered. What students should learn and how difficult to write the test items as well as the complexity level of the accompanying objectives involve subjectivity. There is just as much objectivity involved in assessing daily products/processes from students in a portfolio (See Eddy, et. al.,1997, 478-480).

Students should be evaluated frequently. The Texas Assessment of Academic Skills (TAAS) assesses students annually in grades three through eight. The goal here is to monitor student achievement more thoroughly on a yearly basis. High stakes testing is also in evidence in that high school seniors need to pass the TAAS exit test in order to receive a high school diploma (Hoffman, et.al., 2001). A problem which many states wrestle with is how often a student should be able to retake the exit test. Also. what alternatives are there for a student who on several attempts still fails the exit test. Some have proposed the GED test as an alternative. Certainly, the future is bleak for a student who does not receive a high school diploma.

Constructivists advocate that students be assisted to achieve sequentially, individually, and cooperatively without tests determining cut off points. Paper/pencil tests do not assess students in what is truly important such as perseverance, punctuality, considerateness, and acceptance of others. Predicting what a student will become and do in the future cannot be predicated on having taken one test. In the classroom and school setting together with home cooperation, mathematics teachers can assist each learner to do the best possible in achievement (See Ediger, 1996, 34-40).

High standards and expectations advocates believe that either a standardized test or criterion referenced test (CRT) may be used to determine student measurable achievement results. Standardized achievement tests such as the Iowa Test of Basic Skills or the Stanford Achievement Test have no accompanying objectives to use in teaching whereas a CRT does. The latter can be more valid than the former. However, too frequently, states do not align their tests with the stated standards/objectives. Standardized tests have as their purpose to spread students out from high to low, 99th to the first percentile. Writers of standardized tests have this spreading out concept as a built in concept

in test writing. A sorting process is then involved in that test takers are rated on a continuum on how well they did on the involved test.

Constructivists believe that learning and achievement occur in both school and in society. Quality educational and societal endeavors are important for students to attain background information/abilities. A test narrows opportunities to learn since it restricts what is taught in the classroom to that which covered on the test. Students need to have opportunities to use diverse intelligences possessed to reveal progress in mathematics. They also need to be able to use and apply what has been learned in mathematics. Selected advocates of high standards and expectations for students also agree that multiple measures should be used to ascertain learner achievement. One test alone should not determine a person's future.

Problems in Portfolio Assessment

Portfolio results are much more difficult to document as compared to test results. Thus, there will be no single numeral for each student's results from machine scored tests, be they standardized or CRTs. There are attempts to assess, numerically, portfolios with carefully designed rubrics. A portfolio may then be rated on a five point Likert scale. But, the ratings may vary much due to different perspectives of individual raters for the same portfolio. Then too, a portfolio could be quite voluminous making it complicated to rate the many entries well as being time consuming in the process. With a plethora of entries in a portfolio which show and reveal the quality of student work, problems arise in terms of coming up with the big picture in giving a rating. It might also take up considerable time and effort in coming up with several quality rubrics to rate diverse mathematics entries such as

1. written work including student essays, expository writing, outlines, summaries, creative and academic subject matter writings, book reports, and journal writing.
2. tape recordings of the involved student's oral reports on mathematics content, discussion participation, as well as being engaged in creative and formal dramatics.
3. a video tape of cooperative learning endeavors and experiences involving ongoing mathematics lessons and units of study.
4. art work including a mathematics mural, a bulletin board display, and a construction project, among others. If any item is too large to place inside a portfolio, a snapshot of the product/process for inclusion is acceptable (Ediger, 2000, Chapter Eight).

The philosophy in back of portfolio development is indeed sound in that the teacher, student, administrator , and parents may actually notice sequential achievement, or lack thereof. The ensuing analysis

provides a sound basis for discussing how to assist the individual student to learn as much as possible. Test scores may become an inherent part of the student's portfolio.

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